Mechanics: Work and Energy Note Guide **Name:** KEY

Part I – Definitions:

Work -
GREEN 1. Work done by a constant force is defined as the distance moved multiplied by the component of force in the direction of displacement.
PURPLE 2. The change in kinetic energy of an object

Joule - 1 J = 1 N · m (GREEN 3)
(SI unit for work and KE)

Kinetic Energy - measured in joules, half of the mass and squared velocity

Energy due to the momentum of an object

Potential Energy - by virtue of it's surroundings = STORED ENERGY
- wound up spring
- stretched elastic band
- object above the ground.

(mass × acceleration grav × height)

Mechanical Energy (Conservation) - Sum of the changes in the kinetic energy and in the potential energy is zero – the kinetic and potential energy changes are equal but opposite in sign (In closed system energy is neither created nor destroyed).

Sum of KE + PE, if nothing else present

Power - Rate at which the work is done
- walking vs running up stairs. Difference is power, PEgrav is the same

Watt - (SI unit for power)

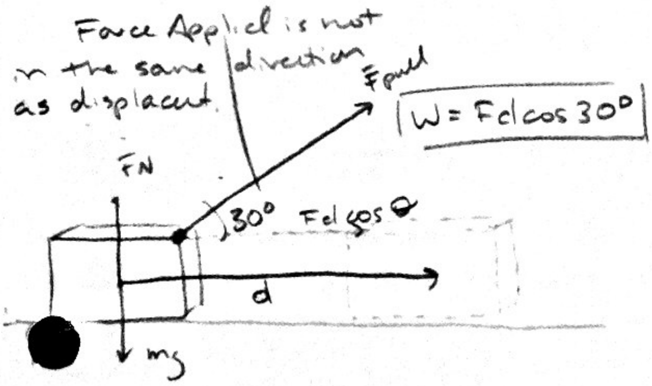
1 W = 1 J/s

WORK DONE BY GRAVITY
- GOING UP: Displacement is upward = Force of gravity down
  $W_g = -mgh$
- GOING DOWN: Displacement & Force gravity down
  $W_g = +mgh$

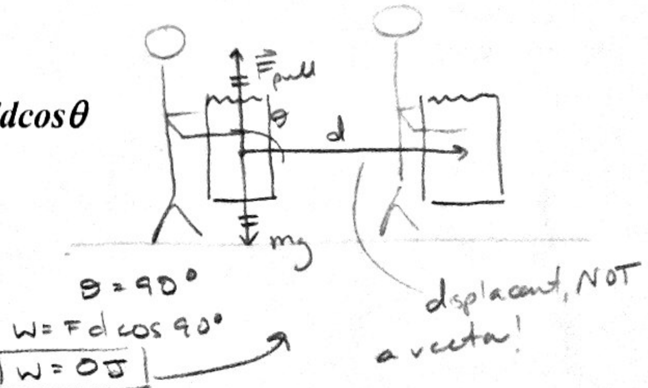
Part II – Understanding the Signs of Work:

- GREEN 3 • Work done by forces that oppose the direction of motion are negative. An example of this would be friction.
- Work done by forces that are in the same direction of motion are positive. An example of this would be ________.
- GREEN 3 • If the applied force is perpendicular to the direction of motion, then the work done is zero.
- GREEN 7 • If the net work is positive, then the kinetic energy increases.
- " • If the net work is negative, then the kinetic energy decreases.

Part III – Vectors:



$W = Fd\cos\theta$



cos(0) = 1 cos(180) = -1 cos(90) = 0

Part IV – Equations:

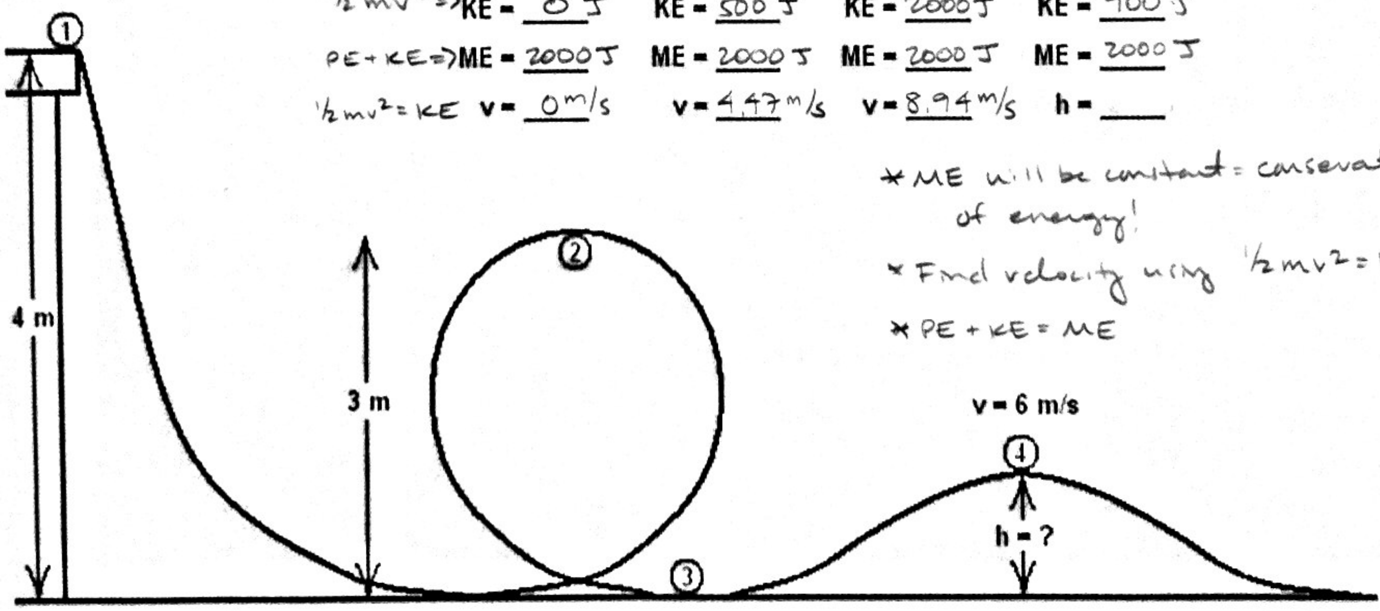
Work	1. $W = Fd\cos\theta$ 2. $W = KE_{after} - KE_{before} = \Delta KE$ $KE = \frac{1}{2}mv^2$ $\Delta KE = Fd\cos\theta$
Kinetic Energy	$W_{net} = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$ $KE = \frac{1}{2}mv^2$ $W_{net} = \Delta KE$
Potential Energy (due to gravity)	$PE_{grav} = mgy$ $PE_{grav} = mgh$ $W_{ext} = F_{ext}\,d\cos 0° = mgh$ (F_{ext} = mg, $\cos 0° = 1$) (where y & h are height) $PE_{elastic} = \frac{1}{2}kx^2$
Mechanical Energy $KE_1 + PE_1 = KE_2 + PE_2$	$E = KE + PE$ (Total energy cannot change) $E_2 = E_1$ = constant → $E = \frac{1}{2}mv^2 + mgh$
Power	$\bar{P}$ = average power = $\frac{\text{work}}{\text{time}} = \frac{\text{energy transformed}}{\text{time}}$

Part V – Conservation of Energy:

Assume gravity = 10 m/s²

	①	②	③	④
mgh =>	PE = 2000 J	PE = 1500 J	PE = 0 J	PE = 1100 J
$\frac{1}{2}mv^2$ =>	KE = 0 J	KE = 500 J	KE = 2000 J	KE = 900 J
PE + KE =>	ME = 2000 J	ME = 2000 J	ME = 2000 J	ME = 2000 J
$\frac{1}{2}mv^2 = KE$	v = 0 m/s	v = 4.47 m/s	v = 8.94 m/s	h = ____

m = 50 kg



* ME will be constant = conservation of energy!
* Find velocity using $\frac{1}{2}mv^2 = KE$
* PE + KE = ME

Purple Slide #4

m = 875.0 kg
$v_1 = 22$ m/s
$v_2 = 44$ m/s

$KE_1 = \frac{1}{2}mv_1^2 = 212{,}000$ J ≈ 212.0 J = KE_1

$KE_2 = \frac{1}{2}mv_2^2 = 847{,}000$ J ≈ 847.0 KJ = KE_2

$\Delta KE = W$

$KE_2 - KE_1 =$ 635.0 KJ = W

Purple Slide #8

m = 2.2 kg
$h_d = 0.80$ m
$h_{sh} = 2.10$ m

$PE_{to\ desk} = mg(h_{sh} - h_d) =$ 28.6 J = PE_{desk}

$PE_{to\ shelf} = mg(h_{sh}) =$ 46.2 J = PE_{floor}